National Transparent Optical Network (NTON)

Creating the next generation in advanced telecommunications networks

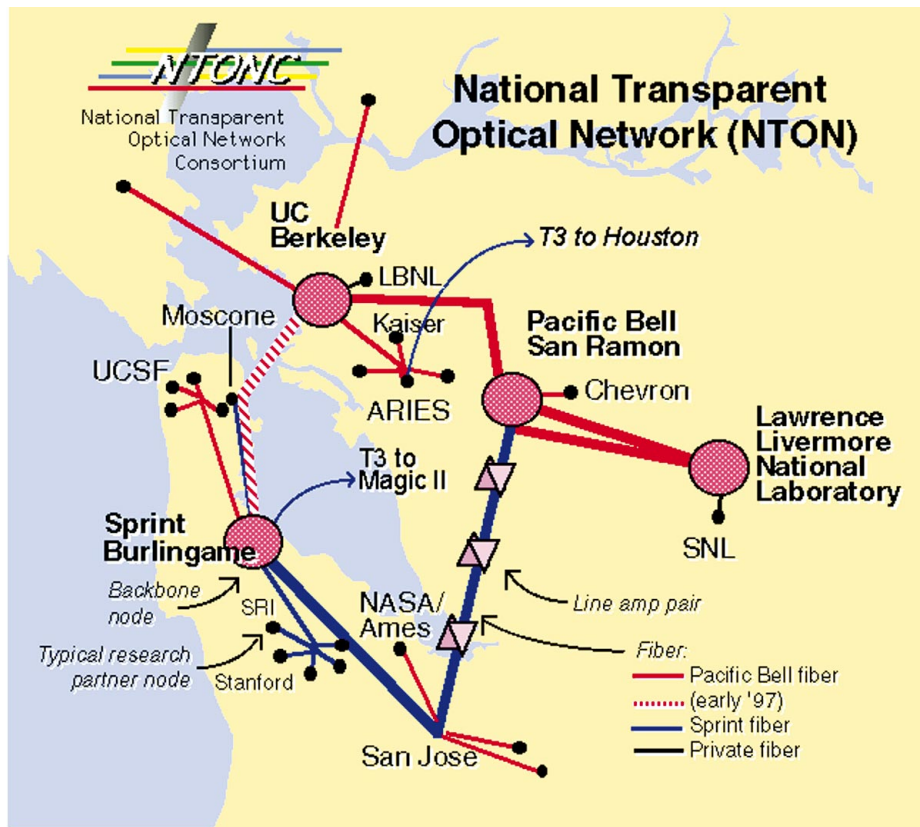National Transparent Optical Network (NTON)

Objective

In collaboration with the National Transparent Optical Network Consortium (NTONC), Lawrence Livermore National Laboratory (LLNL) is integrating the National Transparent Optical Network (NTON), a very high-speed, transparent, all-optical network in the San Francisco Bay Area. This advanced network provides a testbed for complex optical networking technologies, a facility for development and demonstration of high-bandwidth network applications, and a platform for research and development of integrated network management capabilities.

Impact

By deploying this open testbed, the NTON will lead the way to the next generation of commercially provided, advanced all-optical networks. It will accelerate the development of higher capacity, affordable telecommunications infrastructures, which are required to support the growing number of applications involving high-resolution image transport, distributed computing, large file transfers, and video and audio services.

The "information superhighway" vision assumes that every citizen in the U.S. will have easy, affordable access to information and to the economic and educational advantages such a facility will provide. Although we have made this vision a national priority, technical problems still stand in the way of creating a network that is fast enough and inexpensive enough to qualify as the "superhighway." New, all-optical networks, which increase the amount of information carried on each fiber in a network by a hundredfold, are widely recognized to have the potential capacity and flexibility to serve the needs of the information superhighway far into the future. Next-generation, wide-area optical networks will employ wavelength division multiplexing (WDM), along with wavelength routing and optical amplification to achieve a higher capacity, more affordable, telecommunications infrastructure.

To start the nation down the path toward high-speed, all-optical networks, the Department of Defense Advanced Research Projects Agency (DARPA) and the NTONC are jointly funding this "Open All-Optical Network for Flexible Broadband Communications." It will be a transparent (i.e., data format independent), fiber optic network ringing the San Francisco Bay. The NTON will use four separate wavelengths per fiber to achieve a total capacity of over 10 billion bits per second (10+ Gb/s) in each direction.

NTONC

The NTONC, originating in 1994, comprises world leaders in many areas of optical data transmission technology. They are NORTEL (Northern Telecom, which leads the consortium), LLNL (which leads the network integration and deployment of applications), GM Hughes Research Labs, Pacific Bell, Rockwell Science Center, Sprint, Uniphase Telecommunications Products, University of California at San Diego, Columbia University, and Case Western Reserve University. The broad cross-section of NTONC participants ensures that the interests of technology providers, telecommunications carriers, research institutions, and end users are represented. The consortium has created teams in the
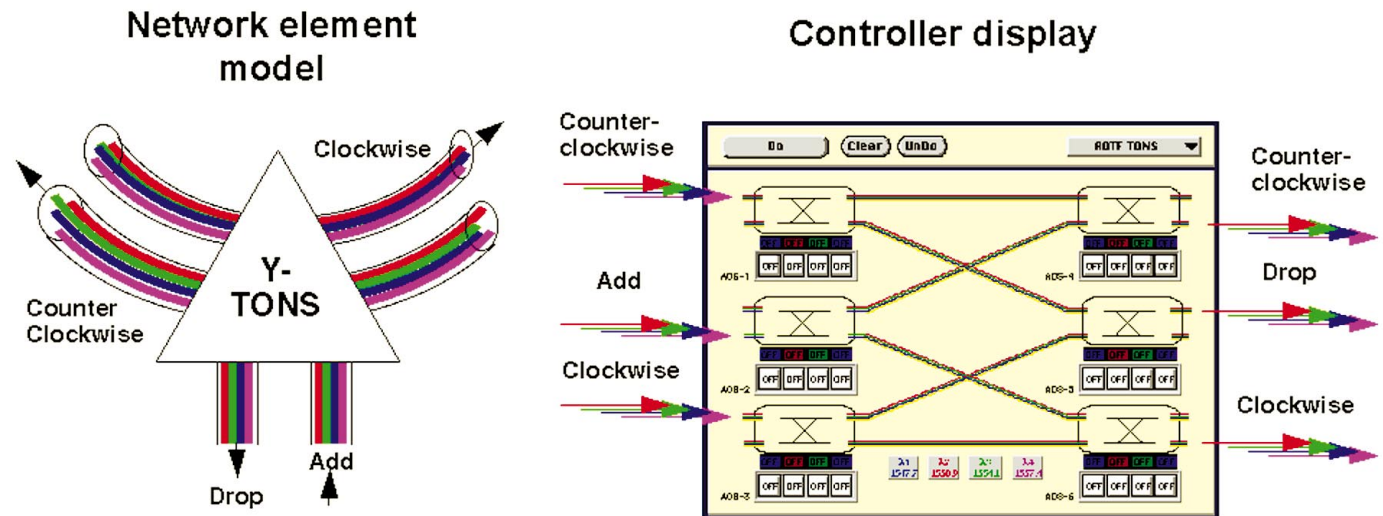
A Y-shaped Transparent Optical Network Switch (TONS) is an optical add/drop multiplexer.

areas of operations, administration and management, network studies, network implementation, and network applications.

As a part of DARPA's Broadband Infrastructure Technology (BIT) Program, there are two thrusts for this project. The first is to establish a prototype network over which high-bandwidth applications can illustrate new optical technologies. The second is to build an open testbed with "real traffic" to test new DARPA-sponsored, optical technologies. This project will be a key contributor to DARPA's goal of demonstrating the viability of WDM networks within five years.

Deployment

The network backbone has access nodes initially at Pacific Bell, Sprint, University of California at Berkeley (UCB) and LLNL. Tributaries to additional user sites will be added to develop and test real applications across the network. The focus on both applications and technologies will result in strategies for commercial deployment of broadband services and optical network technologies.

The project has an aggressive schedule to deploy the prototype network and to support initial user applications by fielding a combination of commercially available and consortium-developed components. Testing and demonstrations began in early 1996 with complete backbone operation planned in mid-1997. The backbone will carry four 2.5+ Gb/s channels, each using a different wavelength. Two wavelengths will be dedicated for high bandwidth applications. In addition, an eight wavelength demonstration will occur on one of the network sections. The majority of the traffic will use the Asynchronous Transfer Mode (ATM) protocol on Synchronous Optical Network (SONET), supporting Internet Protocol (IP) networks. However, traffic adhering to other standards will serve to demonstrate the transparency of the network.

The first optical technologies being tested by the NTONC—Acousto-Optical Tunable Filters (AOTFs) and integrated multi-wavelength transceiver modules—are being developed by the consortium itself. Bellcore originally

developed the AOTF technology and then transferred it to Uniphase Telecommunications Products and Case Western Reserve University. Bellcore also developed the direct modulation laser array components for the transceiver modules. Nortel integrated and packaged these with the Hughes and Rockwell components into the final prototype being deployed. The NTONC will continue to develop, deploy, and evaluate these and other technologies in the NTON.

LLNL and its regional partners have collaborated in several Gigabit/second research wide area networks: AT&T's XUNET (Experimental University Network) project; the OART (Optical Amplifier Reliability Trial) project, a joint Pacific Bell, LLNL, and UCB project; and BAGnet (Bay Area Gigabit Network), a Pacific Bell (CalREN) sponsored project.

For more information about the NTON or NTONC or to discuss potential collaborations, please contact William Lennon, 510-422-1091, wjlennon@llnl.gov; or Robert Bryant, 510-422-4241,rbryant@llnl.gov.